

Controlling of rot root pathogens on cucumber using some plant extracts and bio-control agent *Trichoderma harzianum*

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Abstract

Different fungal pathogens that cause rot root disease have a significant impact on cucumbers, which has a tremendous economic limitation on the yield of this important vegetable crop. The current study aims to examine the effect of cold aqueous extract of three plants (*Acacia farnesiana*, *Myrtus communis* and *Nerium oleander*) on the radial growth and the biomass of some pathogenic fungi (*Rhizoctonia solani* and *Macrophomina phaseolina*) with the presence of *Trichoderma harzianum* as a bio-control agent. Fungal pathogens were isolated from root parts of infected cucumber plants that were collected from different regions of Najaf province, while the bio-control fungus was obtained from the Bio-control Laboratory, Faculty of Agriculture - University of Kufa. Results of the current study showed that 20% of the cold aqueous extract of *M. communis* powder was superior to the rest of the studied extracts in inhibiting the radial growth of studied fungi, as the radial growth of *R. solani* reached 3.49cm, *M. phaseolina* 3.02cm, and *T. harzianum* 3.67cm. The apparent effect of the same extra extract on the growth of the fresh and dry biomass of the aforementioned fungi. The outcomes demonstrated that the 20% concentration of cold aqueous extract of *M. communis* also increased the percentage of seed germination and the fresh weight of cucumber plants. The cold aqueous extract of *M. communis* leaves and *T. harzianum* as a biological can be used , to inhibit the growth of both pathogens of rot root disease, thus protecting cucumber seedlings and producing healthy plants.



Keywords: cucumber, rot root, plant extract, bio-control agent, pathogenic fungi.

Introduction

Soil-borne pathogens, particularly fungi, are extremely dangerous to crops as, in recent years, many diseases have emerged, including seedlings death and root rot diseases caused by the pathogenic fungi of soil (4). These fungi are endemic to the soil and have complex relationships with the surrounding environment (17). The threat of root rot is still the main challenge that facing the agricultural crops globally as it grows away from human sight with a wide range of plant hosts as well as they can resist unsuitable environmental conditions and can remain in the soil and plant residues for a long time (22).

Many methods have been used to control plant diseases, especially the use of chemical control as it gives fast and control; however, most of chemical fungicides are polluted and toxic to human and animal and have adverse effect on other soil microorganisms (20). In addition, some fungi can resist to these chemicals which forces agricultural research institutions to find other solutions (15). Therefore, plant extracts were used to

control the pathogenic fungi and some of these natural products achieved advanced levels of eliminating fungal pathogens as it presents naturally in plant and has antifungal activity and can be degraded very fast (12). However, it has received significant attention in recent years, as the extracts of medicinal plants and herbs have been used as sources for the production of medicinal drugs or as a source of active ingredients that go into drug formulation (5).

Many studies have addressed the effect of these extracts on the growth of microorganisms, and thus they can be used in treating some different microbial diseases (8, 10 and 13). Many wild plants were grown in Iraq, which have a great impact and importance when exploited as antifungals or in the manufacture of commercial fungicides of plant origin for some pathogens of fungal plant diseases. Therefore, the study aimed to determine the effect of cold aqueous extract of the leaves of *A. farnesiana*, *M. communis* and *N. oleander* plants in protecting cucumber plants from infection with rot root pathogens.



Materials and methods

Isolation of fungi used in the study

Fungi were isolated from the roots and crown area of infected cucumber seedlings. The infected parts were washed with running water to remove dust, and then they were sterilized with a 2% sodium hypochlorite solution for 3 minutes, washed several times with sterile water, and then placed on a sterile filter paper to remove the water. The infected parts were cut into small pieces about 0.5-1cm long and planted in Petri plates containing P.D.A. culture medium. Sterilized and incubated in the incubator at a $(25\pm 2)^{\circ}\text{C}$ temperature. After the growth of fungal colonies, they were purified and diagnosed in the Plant Diseases Laboratory of the Plant Protection Department, Faculty of Agriculture, University of Kufa, based on the characteristics mentioned by Parmeter and Whitney (18) and Poudel and Vaghefi (19).

Trichoderma harzianum isolate

T. harzianum isolate was used as a bio-control agent, which was obtained from the Biocontrol Laboratory, Faculty of Agriculture - University of Kufa, and has shown high efficiency as a biocontrol agent

against many plant pathogens as well as stimulating plant growth in previous studies.

Preparation of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* leaves

The medium was prepared by adding (0, 5, 10, 20) grams of leaf powder for each of *A. farnesiana*, *M. communis* and *N. oleander* plants, on a dry weight basis, to 1000 mL of sterile distilled water. The mixture was soaked for 24 hours, and then filtered into another beaker using a piece of gauze cloth (fidget) to get the extract. 39 grams of the prepared nutrient medium (P.D.A.) were added to the filtrate and the volume was completed to one liter, each separately. It was sterilized in an autoclave at 121°C and 15 lb/ang² for 20 minutes and poured into Petri plates according to the requirements of the experiment, and same media was prepared to obtain liquid medium.

The effect of cold aqueous extract of powdered leaves of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of pathogenic fungi and *T. harzianum* in Petri plates

The centres of Petri plates were inoculated after the P.D.A. nutrient medium was get solid, which contains the cold aqueous



extract of powdered leaves of *A. farnesiana*, *M. communis* and *N. oleander* plant, with 0.5cm diameter discs from the edge of 7-day-old colonies of each fungus used in the study with three replicates for each concentration, taking into account the comparison of control treatment (P.D.A. only), then plates were incubated at $25\pm 2^{\circ}\text{C}$, and the distance of diagonal growth was calculated after every 24 hours and cumulatively for 3 days using a transparent ruler as well as the percentage of inhibition was also calculated according to the equation of Abbot (2).

The effect of cold aqueous extract of leaf powder of *A. farnesiana*, *M. communis* and *N. oleander* on the growth of the biomass of pathogenic fungi and *T. harzianum*

Pathogenic fungi and *T. harzianum* were grown by inoculating 250 mL glass bottles containing 100 mL of the above-mentioned extracts with three 0.5cm discs of the aforementioned fungi, individually, in three replicates, taking into account the use of P.D.B. as control, the beakers were incubated in the incubator at $25\pm 2^{\circ}\text{C}$ for 28 days. The fungal cultures were filtered through the Whatman 0.01 type filter paper,

then the fungal mass was transferred to a sensitive scale, and the fresh and dry weight was calculated.

The effect of pathogenic fungi and *T. harzianum* treated with concentrations of cold aqueous extract of *M. communis* on the germination and growth of cucumber plants in pots

This experiment was carried out by planting cucumber seeds in small plastic pots with a capacity of 250 grams containing agricultural soil to which some pathogenic fungi and *T. harzianum* were added, treated with concentrations of the cold aqueous extract of the leaf powder of *M. communis* plant separately, and according to the following treatments:

Soil only

Soil + 5% cold extract

Soil + 10% cold extract

Soil + 20% cold extract

Soil + R.s

Soil + R.s + 5% cold extract

Soil + R.s + 10% cold extract

Soil + R.s + 20% cold extract

Soil + M.p



Soil + M.p. + 5% cold extract

Soil + M.p. + 10% cold extract

Soil + M.p. + 20% cold extract

Soil + T.h

Soil + T.h + 5% cold extract

Soil + T.h + 10% cold extract

Soil + T.h + 20% cold extract

After 10 days, the percentage of seed germination was calculated, as well as rotten seeds dead and healthy seedlings, and after 15 days, the shoot and root lengths and fresh weight were calculated.

Effect of dipping cucumber seeds in cold aqueous extract of *M. communis* on the growth of pathogenic fungi and *T. harzianum* and growth of cucumber plants in pots

This experiment was carried out by dipping cucumber seeds in concentrations of cold aqueous extract of the powdered leaves of the *M. communis* plant and cultivating them in small plastic pots with a capacity of 250 grams containing agricultural soil to which

some pathogenic fungi and *T. harzianum* were added separately.

After 10 days, the percentage of seed germination was calculated, as well as rotten seeds, and dead and healthy seedlings, and after 15 days, the shoot and root lengths and fresh weight were calculated.

Germination percentage =

Number of germinated seeds

$$\frac{\text{Number of germinated seeds}}{\text{Total number of seeds}} \times 100$$

Percentage of rotten seeds =

Number of rotten seeds

$$\frac{\text{Number of rotten seeds}}{\text{Total number of seeds}} \times 100$$

Statistical analysis

The laboratory experiments were carried out according to the Complete Randomized Block Design (C.R.D.). The field experiment was designed according to the Complete Randomized Block Design (C.R.B.D.), and the means were compared using the Least Significant Difference (L.S.D.) under the probability level of 0.05.

Results and Discussion

The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of *R. solani*

Results of Table 1 indicate that the cold aqueous extract of the leaves of *A. farnesiana* plant led to a reduction in the radial growth of *R. solani* in Petri plates, where the growth rate reached 3.97 cm compared to the cold aqueous extract of the leaves of *M. communis* and *N. oleander*. The effect of the concentration factor on the radial growth of *R. solani* showed that the

concentration of 20 grams of cold water extract of *A. farnesiana* was reduced the radial growth of *R. solani* to 3.49cm compared to the rest of studied concentrations of plant extracts (Fig 1). The effect of time on the growth of *R. solani* increased when the time period increased. Results of the triple interaction effect indicated that 20 grams of cold aqueous extract of *A. farnesiana* leaves led to 1.63cm reduction in the radial growth of *R. solani* compared to the rest of the interaction treatments.

Table 1. The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of *R. solani* in Petri plates.

Plant type	Concentration	Radial growth of <i>R. solani</i> (cm)			Average of plants	Average of concentration
		Time (h)				
		24	48	72		
<i>A. farnesiana</i>	0	3.58	5.36	8.50		
	5	3.26	4.60	7.03		5.81
	10	2.98	4.28	7.11	4.87	
	20	2.43	3.61	5.80		
<i>M. communis</i>	0	3.58	5.36	8.50		4.92
	5	2.45	3.45	5.75		
	10	2.58	3.71	5.58	3.97	4.59
	20	1.63	1.71	3.40		
<i>N. oleander</i>	0	3.58	5.36	8.50		
	5	3.70	5.55	8.50		



10	3.11	4.65	7.38	5.26	3.49
20	2.68	4.10	6.08		
Average of time	2.96	4.31	6.84		
L.S.D=0.05	Plants= 1648 Concentration= 0.1903 Time= 0.1648 Interaction= 0.5709				

The least significant difference = $P > 0.05$

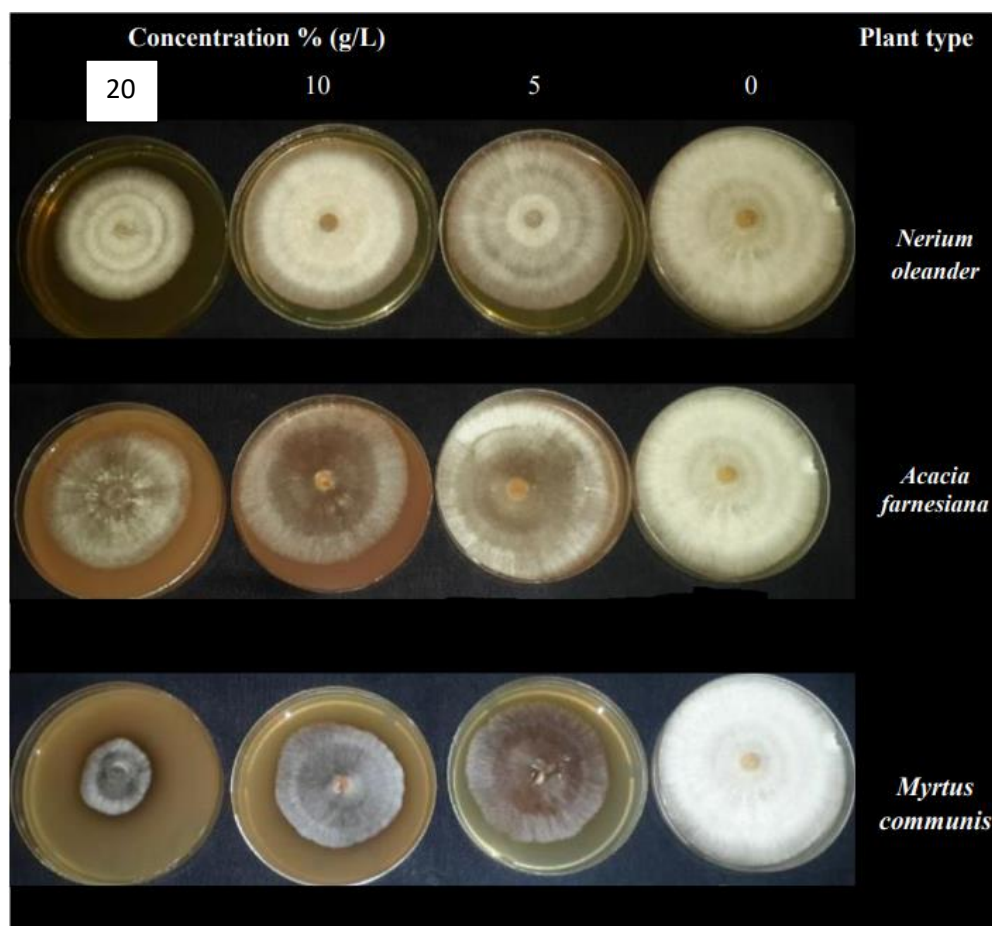


Figure 1. Shows the effect of different concentrations of cold aqueous extract of studied plants on the radial growth of *R. solani* in Petri plates

The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of *M. phaseolina*

Table 2 results showed that the cold aqueous extract of *M. communis* leaves reduced the radial growth of *M. phaseolina* fungus in Petri plates, where the growth rate reached

3.02cm compared to the radial growth of the fungus on the cold aqueous extract of *N. oleander* and *A. farnesiana* leaves (Fig 2). Studying the effect of the concentration factor on the radial growth of *M. phaseolina*, it was found that the concentration of 20g of the cold aqueous extract of *M. communis* leaves led to a reduction in the radial growth of the fungus, which reached 2.72cm compared to the rest of the concentrations

studied for the extracts of *N. oleander* and *A. farnesiana*. The effect of the time factor on the growth of the fungus showed an increase of the radial growth when increasing the period. Result of the triple interaction showed that the concentration of 20g of the cold aqueous extract of *M. communis* leaves was reduced the radial growth of *M. phaseolina* up to 0cm compared to the rest of the interactions.

Table 2. The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of *M. phaseolina* in Petri plates.

Plant type	Concentration	Radial growth of <i>M. phaseolina</i> (cm)			Average of plants	Average of concentration
		Time (h)				
		24	48	72		
<i>A. farnesiana</i>	0	4.75	6.50	8.50		
	5	4.50	6.46	8.50	6.15	6.40
	10	4.53	6.35	8.50		
	20	3.63	5.00	6.60		
<i>M. communis</i>	0	4.75	6.50	8.50		5.07
	5	3.15	3.36	4.06	3.02	
	10	1.35	1.83	2.75		
	20	0.00	0.00	0.00		4.21
<i>N. oleander</i>	0	4.75	6.50	8.50		
	5	3.78	5.46	6.38	4.82	
	10	2.65	4.10	5.80		2.72
	20	2.33	3.21	4.36		
Average of time		3.34	4.60	6.03		



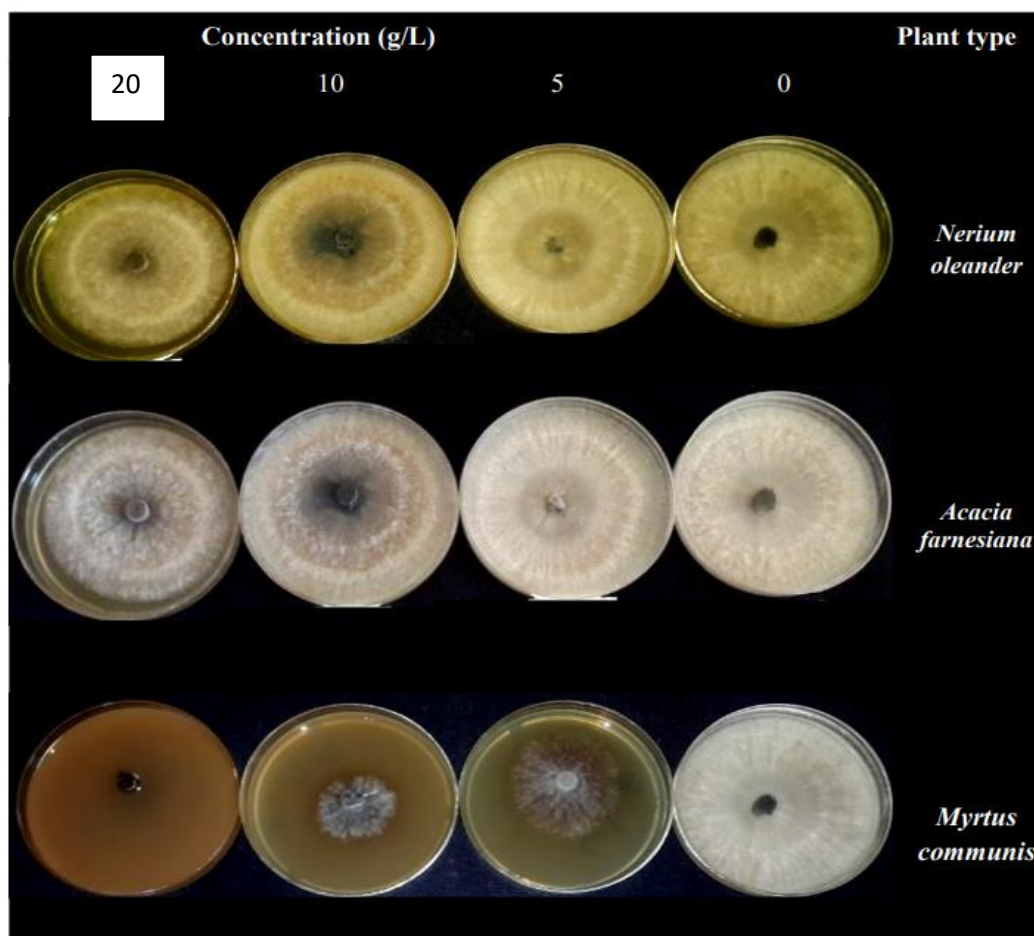
L.S.D=0.05Plants= 0.111 Concentration= 0.13 Time= 0.11 Interaction=
0.4126The least significant difference = $P > 0.05$ 

Figure 2. Shows the effect of different concentrations of cold aqueous extract of studied plants on the radial growth of *M. phaseolina* in Petri plates

The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of *T. harzianum*

Results indicate that the cold aqueous extract of *M. communis* leaves led to a reduction in the radial growth of *T. harzianum* in Petri

plates, where the growth rate reached 3.67cm compared to the radial growth of the fungus on the cold aqueous extract of *N. oleander* and *A. farnesiana* leaves (Table 3 and Fig 3). The concentration factor effect on the radial growth of *T. harzianum* showed

that the concentration of 20g of the cold aqueous extract of *M. communis* leaves was reduced the radial growth of *T. harzianum*, where it reached 4.40cm compared to the rest of the concentrations studied for other plant extracts. The effect of the time on the growth of the *T. harzianum* was increased

when increase the time period, while the results of the triple interaction showed that the concentration of 20g of the cold aqueous extract of *M. communis* leaves led to a reduction in the radial growth of *T. harzianum*, where it reached 0.58cm compared to the rest of the interactions.

Table 3. The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the radial growth of *T. harzianum* in Petri plates.

Plant type	Concentration	Radial growth of <i>T. harzianum</i> (cm)		Average of plants	Average of concentration
		Time (h)			
		24	48		
<i>A. farnesiana</i>	0	5.51	8.50	6.98	7.01
	5	5.46	8.50		
	10	5.43	8.50		
	20	5.50	8.50		
<i>M. communis</i>	0	5.51	8.50	3.67	5.69
	5	2.53	4.46		
	10	1.90	3.88		
	20	0.58	2.03		
<i>N. oleander</i>	0	5.51	8.50	6.32	4.40
	5	4.66	8.50		
	10	5.10	8.50		
	20	3.25	6.53		
Average of time		4.24	7.07		
L.S.D=0.05		Plants= 0.13	Concentration= 0.15	Time= 0.1	Interaction= 0.37

The least significant difference = $P > 0.05$



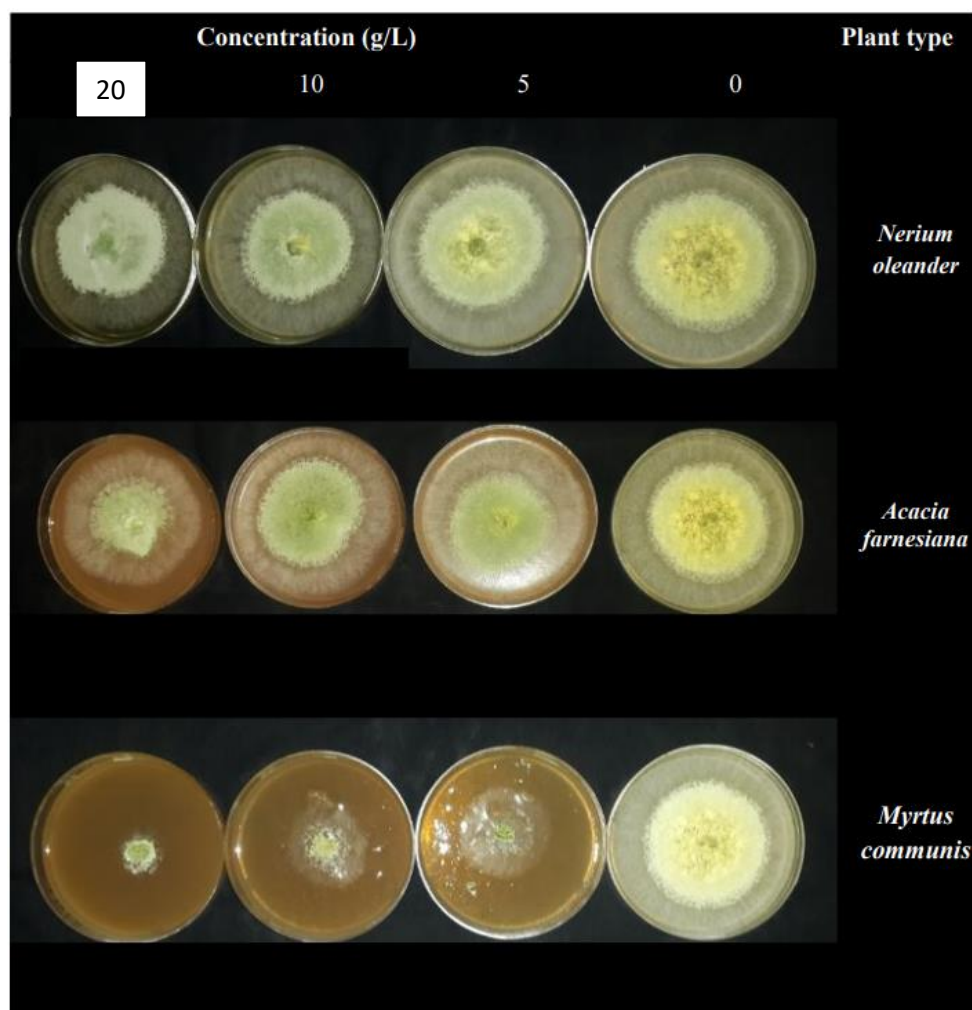


Figure 3. Shows the effect of different concentrations of cold aqueous extract of studied plants on the radial growth of *T. harzianum* in Petri plates

The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the growth of fresh biomass of pathogenic fungi and *T. harzianum*

The results, as shown in Table (4), indicate that the cold aqueous extract of *N. oleander* leaves reduced the fresh biomass of the studied fungi, which reached an average of

2.65g compared to the growth in the rest of the extracts. When studying the effect of the concentration factor on the growth of the fresh biomass of the fungi, the 5g of the cold aqueous extract of *N. oleander* leaves led to a reduction in the growth of the fresh biomass of the fungi, where it reached 1.16g compared to the rest of the concentrations

studied for other plant extracts. Also, when studying the effect of plant extracts on the growth of the fresh biomass of the studied fungi, it became clear that *M. phaseolina* and *T. harzianum* were the most affected by the extracts, where the fresh biomass reached 1.70g for each. The effect of the triple

interaction, the concentrations of 5 and 10g of the cold aqueous extract of *N. oleander* leaves reduced the growth of the fresh biomass of *M. phaseolina* and *T. harzianum*, where it reached 0g for each compared to the rest of the interactions.

Table 4. The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the growth of fresh biomass of pathogenic fungi and *T. harzianum*.

Plant type	Concentration	Growth of fresh biomass (g)			Average of plants	Average of concentration
		Fungi				
		<i>R. solani</i>	<i>M. phaseolina</i>	<i>T. harzianum</i>		
<i>A. farnesiana</i>	0	8.88	2.45	2.45	3.15	4.59
	5	3.03	1.23	1.23		
	10	3.66	2.82	2.82		
	20	4.73	2.20	2.20		
<i>M. communis</i>	0	8.88	2.45	2.45	2.65	1.16
	5	1.99	0.00	0.00		
	10	2.67	0.00	0.00		
	20	5.10	1.82	1.82		
<i>N. oleander</i>	0	8.88	2.45	2.45	2.75	2.69
	5	2.14	0.41	0.41		
	10	2.00	1.42	1.42		
	20	0.00	3.19	3.19		
Average of fungi		4.33	1.70	1.70	4.33	
L.S.D=0.05		Plants= 0.565	Concentration= 0.653	Time= 0.653	Interaction= 2. 261	

The least significant difference = $P > 0.05$



The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the dry biomass of pathogenic fungi and *T. harzianum*

The outcomes indicate that the cold aqueous extract of the leaves of the *N. oleander* plant reduced the dry biomass of the studied fungi, where it reached an average of 0.21g compared to the rest of the extracts (Table 5). The effect of the concentration of the studied plant extracts on the growth of the dry biomass of the fungi showed that the 5g of cold aqueous extract of *N. oleander* led to

a reduction in the growth of the dry biomass of all studied fungi, where it reached 0.07g compared to the rest of the concentrations. The effect of the extracts on the growth of the dry biomass of fungi showed that the fungus *T. harzianum* was the most affected by the extracts, where the dry biomass reached 0.18g. Results of the effect of the triple interaction showed that the 5 and 10g concentrations of the cold aqueous extract of the leaves of *A. farnesiana* was reduced the growth of the dry biomass of *M. phaseolina* and *T. harzianum*, where it reached 0g for each compared to the rest of the interactions.

Table 5. The effect of cold aqueous extract of *A. farnesiana*, *M. communis* and *N. oleander* on the dry biomass of pathogenic fungi and *T. harzianum*.

Plant type	Concentration	Dry biomass (g)			Average of plants	Average of concentration
		<i>R. solani</i>	<i>M. phaseolina</i>	<i>T. harzianum</i>		
<i>A. farnesiana</i>	0	0.95	0.45	0.45	0.24	0.62
	5	0.16	0.04	0.04		
	10	0.13	0.31	0.11		
	20	0.21	0.19	0.16		
<i>M. communis</i>	0	0.95	0.45	0.45	0.21	0.07
	5	0.12	0.00	0.00		
	10	0.14	0.00	0.00		
	20	0.20	0.12	0.27		
<i>N. oleander</i>	0	0.95	0.45	0.45	0.22	0.16
	5	0.20	0.02	0.07		

10	0.12	0.08	0.09
20	0.00	0.20	0.11
Average of fungi	0.34	0.19	0.18
L.S.D=0.05	Plants= 0.03513 Concentration= 0.04056 Time= 0.04056 Interaction= 0. 14051		

The least significant difference = $P > 0.05$

The significant effect of using soil + 20% concentration of the cold aqueous extract of *M. communis* leaves treatment led to an increase in the percentage of cucumber seeds germination, which reached 80.82% compared to the rest of the treatments (Table 6). The soil+ fungus treatment decreased the percentage of cucumber seeds germination to 55.83%. While the effect of the fungus on the percentage of seeds germination showed that the *T. harzianum* was increased the percentage of cucumber seed germination to 74.99%, whereas the *R.solani* was decreased

the percentage of seeds germination which reached 72.08%. The effect of the interaction between the treatments and the fungi indicated that the soil + 5% and soil + 10% cold aqueous extract of *M. communis* leaves treatments with *R.solani* fungus were increased the percentage of cucumber seeds germination by up to 86.66% for each treatment. In comparison, the interaction between the soil + *R.solani* fungus treatment decreased the germination percentage to 20%.

Table 6. The effect of adding pathogenic fungi and *T. harzianum* treated with different concentration of cold aqueous extract of *M. communis* on the percentage of cucumber seeds germination in the plastic pots after 10 days of planting.

Treatments	The percentage of cucumber seeds germination (%)			The effect of treatments
	Fungi			
	<i>R. solani</i>	<i>M. phaseolina</i>	<i>T. harzianum</i>	
Soil only	70.00	80.00	73.33	73.33



Soil+5% cold extract	80.00	70.00	80.00	77.50
Soil+10% cold extract	70.00	80.00	70.00	72.50
Soil+20% cold extract	80.00	70.00	83.30	80.82
Soil+ fungus	20.00	63.33	80.00	55.83
Soil+ fungus +5% cold extract	86.66	73.33	80.00	75.83
Soil+ fungus +10% cold extract	86.66	63.33	60.00	71.66
Soil+ fungus + 20% cold extract	83.33	80.00	73.33	76.66
The effect of fungi	72.08	72.49	74.99	
L.S.D=0.05	Treatments= 7.775 Fungi= 5.497 Interaction= 15.549			

Table 7 results indicate that the treatment soil + fungus + 20% concentration of cold aqueous extract of *M. communis* was increased the fresh weight of cucumber plants, which amounted 2.05 g compared to the rest of the treatments. It can be noted that the treatment soil + fungus led to a decrease in the fresh weight of cucumber plants which amounted 1.23g. The effect of the fungi factor on the fresh weight of cucumber

plants showed that the *T.harzianum* was increased to 1.84g, while *R.solani* decreased the fresh weight of cucumber plants to 1.62 g. The interaction between the treatments and fungi indicated that the treatment soil + *R.solani* was decreased the fresh weight of plants. The cucumber plants are ripe to zero because most of the seeds rotted, leading to the seedlings' death after the outbreak due to the pathogenic fungus.

Table 7. The effect of adding pathogenic fungi and *T. harzianum* treated with different concentration of cold aqueous extract of *M. communis* on the fresh weight of cucumber in the plastic pots after 10 days of planting.

Treatments	Fresh weight (g)			The effect of treatments
	Fungi			
	<i>R. solani</i>	<i>M. phaseolina</i>	<i>T. harzianum</i>	
Soil only	1.71	1.71	1.71	1.71
Soil+5% cold extract	1.77	1.77	1.77	1.77



Soil+10% cold extract	1.62	1.62	1.62	1.62
Soil+20% cold extract	2.00	2.00	2.00	2.00
Soil+ fungus	0.00	1.44	1.69	1.23
Soil+ fungus +5% cold extract	2.01	1.74	1.60	1.78
Soil+ fungus +10% cold extract	2.11	2.01	1.94	2.01
Soil+ fungus + 20% cold extract	1.75	2.37	2.07	2.05
The effect of fungi	1.62	1.83	1.84	
L.S.D=0.05	Treatments= 0.1767 Fungi= 0.1250 Interaction= 0.3535			

Soil + 20% concentration of cold aqueous extract of <i>M. communis</i> treatment was increased the percentage of cucumber seeds germination which reached 80.83% compared to the rest of the studied treatments (Table 8). The treatment soil + fungus + 10% concentration of cold aqueous extract of <i>M. communis</i> was decreased the percentage of seeds germination to 68.66%. The effect of the fungus on the percentage of cucumber seed germination showed that <i>R. solani</i> was increased the percentage which	reached 77.08%, while the <i>T. harzianum</i> was decreased this percentage to 73.33%. The interaction between the treatments indicated that the soil + fungus + 20% concentration of cold aqueous extract of <i>M. communis</i> with <i>R.solani</i> treatment led to an increase in the percentage of cucumber seed germination with up to 90%, while the interaction between soil + fungus + 10% concentration of cold aqueous extract of <i>M. communis</i> and <i>T. harzianum</i> was reduced the percentage of cucumber seed germination to 56.66%.
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Table 8. The effect of dipping cucumber seeds on different concentrations of cold aqueous extract of *M. communis* on the percentage of cucumber seed germination in the soil of plastic pots that contains pathogenic fungi and *T. harzianum* after 10 days of planting.

Treatments	The percentage of cucumber seeds germination (%)			The effect of treatments
	Fungi			
	<i>R. solani</i>	<i>M. phaseolina</i>	<i>T. harzianum</i>	
Soil only	80.00	73.33	80.00	75.83

Soil+5% cold extract	80.00	80.00	70.00	75.00
Soil+10% cold extract	70.00	73.33	70.00	71.66
Soil+20% cold extract	80.00	80.00	80.00	80.83
Soil+ fungus	66.66	76.66	80.00	76.66
Soil+ fungus +5% cold extract	73.33	80.00	70.00	76.66
Soil+ fungus +10% cold extract	76.66	66.66	56.66	68.33
Soil+ fungus + 20% cold extract	90.00	63.33	80.00	80.00
The effect of fungi	77.08	74.16	73.33	
L.S.D=0.05	Treatments= 8.89 Fungi= 6.29 Interaction= 1.1963			

Results of Table 9 showed that the treatment soil + fungus + 20% concentration of cold aqueous extract of *M. communis* was increased the fresh weight of cucumber plants, which amounted 2.24 g compared to the rest of the treatments. While the treatment soil + 10% of cold aqueous extract of *M. communis* was decreased the fresh weight to 1.62g. The effect of fungi on the fresh weight of cucumber plants showed that *R. solani* led to an increase in the fresh weight, which amounted to 2.15g, while *M.*

phaseolina and *T. harzianum* were decreased the fresh weight which amounted to 1.90g for each. The interaction between the treatments and fungi indicated that the treatment soil + fungus + 20% concentration of cold aqueous extract of *M. communis* with *R.solani* was increased the fresh weight of cucumber plants up to 2.64g, while the interaction between the treatment soil + 10% of cold extract of *M. communis* with all fungi resulted in a reduction in the fresh weight of cucumber plants to 1.62g for each.

Table 9. The effect of dipping cucumber seeds on different concentrations of cold aqueous extract of *M. communis* on fresh weight of cucumber in plastic pots that contains pathogenic fungi and *T. harzianum* after 10 days of planting.

Treatments	Fresh weight (g)			The effect of treatments
	Fungi			
	<i>R. solani</i>	<i>M. phaseolina</i>	<i>T. harzianum</i>	

Soil only	1.71	1.71	1.71	1.71
Soil+5% cold extract	1.77	1.77	1.77	1.77
Soil+10% cold extract	1.62	1.62	1.62	1.62
Soil+20% cold extract	2.00	2.00	2.00	2.00
Soil+ fungus	2.49	2.09	2.00	2.16
Soil+ fungus +5% cold extract	2.32	2.04	1.69	2.07
Soil+ fungus +10% cold extract	2.70	2.17	2.09	2.20
Soil+ fungus + 20% cold extract	2.64	2.04	2.36	2.24
The effect of fungi	2.15	1.93	1.90	
L.S.D=0.05	Treatments= 0.1885 Fungi= 0.1333 Interaction= 0.3769			

The effect of cold aqueous extract of some plant can be considered as effective method to control rot root disease on cucumber caused by *R. solani* and *M. phaseolina* with the biological agent *T. harzianum*. Using 20% concentration of the cold aqueous extract of *M. communis* powder was significant in inhibiting the radial growth of studied fungi. There was also a clear effect of this extract on the growth of the fresh and dry biomass of the studied fungi. The outcomes determined that the 20% concentration extract of *M. communis* also increased the percentage of seed germination and the fresh weight of cucumber plants. The effect of aqueous extracts of some plants on the growth of fungi has been indicated in many studies (1), for instance, the aqueous extract of *Hedychium spicatum* plant clearly affected the growth rate of the

fungus *R. solani*, and that the reason for the inhibition may be due to the extract containing toxins or antidotes as one of the secondary metabolic products of parasitic or saprophytic fungi on plant tissues during the crushing of those tissues and the action of the extract from them, which led to a reduction in the diameter growth of fungi and inhibition of their action (3 and 7). The reason for the effectiveness of these extracts on the radial growth of pathogenic fungi may also be due to the fact that these plants contain chemical compounds that have a negative effect on the growth of the fungus *R. solani*, which were released when added to the culture medium, which led to a change in the natural properties of the medium and made it less suitable for the growth of the fungus. The differences in the effectiveness of plant extracts can be attributed to their



differences in the contents of active ingredients (16, 11 and 9). The main compounds in plant extracts are mostly phenols, flavonoids, alkaloids, ketones, saponins, tannins and sterols (21). Their properties as a natural fungicides or growth inhibitors have been recorded. These components of the active ingredients have either a direct inhibitory effect on pathogens, which exposes the effects of the beginning or inhibitory, as these compounds may help establish or be the beginning of conditions conducive to antagonistic organisms (6). The results of current study are consistent with what was reached by Jubair et al., (14) who studied the use of *T. harzianum* filtrate and alcoholic extract of *M. communis* leaves to protect cucumber seedling against *R. solani*.

The *T. harzianum* as a biological and the cold aqueous extract of *M. communis* leaves can be used in inhibiting the growth of the both pathogens *R. solani* and *M. phaseolina*

thus, protecting cucumber plants and seedlings from the infection by this critical disease.

Conclusion

The combination of plant extracts and *T. harzianum* can significantly reduce or even eliminate rot root disease on cucumber. Due to its high content of various bioactive compounds for inhibiting the radial growth of *R. solani* and *M. phaseolina* and the growth of the fresh and dry biomass as well as promoting cucumber plants growth. Phytoextracts could be produced as a cheap source of raw material to protect plants and environment friendly compared to synthetic fungicides that may harm the natural ecosystem. Further studies need to be done on these cold aqueous extracts in the field to confirm the commercial use.

Conflict of interest

The authors declare no conflict of interest.

References

1. Abbas, A.M., Novak, S.J., Fictor, M., Mostafa, Y.S., Alamri, S.A., Alrumman, S.A., Taher, M.A., Hashem, M. and Khalaphallah, R. 2022. Initial in Vitro assessment of

the antifungal activity of aqueous extracts from three invasive plant species. Agriculture, 12(8): 1152. <https://doi.org/10.3390/agriculture12081152>



2. **Abbott, E. V. 1923.** The occurrence and action of fungi in soils. *Soil Science*, 16(3): 207.
3. **Abd-El-Khair, H. and El-Gamal Nadia, G. 2011.** Effects of aqueous extracts of some plant species against *Fusarium solani* and *Rhizoctonia solani* in *Phaseolus vulgaris* plants. *Archives of Phytopathology and Plant Protection*, 44(1): 1-16.
4. **Bastakoti S., Belbase S., Manandhar S. and Arjyal C. 2017.** *Trichoderma* species as biocontrol agent against soil borne fungal pathogens. *Nepal Journal of Biotechnology*, 5(1): 39-45.
5. **Bolouri, P., Salami, R., Kouhi, S., Kordi, M., Asgari Lajayer, B., Hadian, J., and Astatkie, T. 2022.** Applications of essential oils and plant extracts in different industries. *Molecules*, 27(24): 8999.
6. **Caesar, L. K. and Cech, N. B. 2019.** Synergy and antagonism in natural product extracts: when 1+ 1 does not equal 2. *Natural Product Reports*, 36(6): 869-888.
7. **Chaudhary, S., Gupta, A.K., Samuel, C.O. and Upadhyaya, P.P. 2018.** Study of various fungitoxic properties of aqueous extract of *Hedychiumspicatum* against *Rhizoctonia solani* Kuhn. *Journal of Pure and Applied Microbiology*, 12(1): 301-307.
8. **Chen, J. and Dai, G. H. 2014.** Effect of D-pinitol isolated and identified from *Robinia pseudoacacia* against cucumber powdery mildew. *Scientia Horticulturae*, 176: 38-44.
9. **Godlewska, K., Ronga, D. and Michalak, I. 2021.** Plant extracts-importance in sustainable agriculture. *Italian Journal of Agronomy*, 16(2): 1-23.
10. **Gonelimali, F. D., Lin, J., Miao, W., Xuan, J., Charles, F., Chen, M. and Hatab, S. R. 2018.** Antimicrobial properties and mechanism of action of some plant extracts against food pathogens and spoilage microorganisms. *Frontiers in Microbiology*, 9: 389103.



11. **Haider, E., Khan, M. A., Atiq, M., Shahbaz, M. and Yaseen, S. 2020.** Phytoextracts as management tool against fungal diseases of vegetables. *International Journal of Bioscience*, 16(3): 303-314.
12. **Hassan, H. S., Mohamed, A. A., Feleafel, M. N., Salem, M. Z., Ali, H. M., Akrami, M. and Abd-Elkader, D. Y. 2021.** Natural plant extracts and microbial antagonists to control fungal pathogens and improve the productivity of zucchini (*Cucurbita pepo* L.) in vitro and in greenhouse. *Horticulturae*, 7(11): 470.
13. **Jia, H., Wang, Z., Kang, X., Wang, J., Wu, Y., Yao, Z., Zhou, Y.; Li, Y.; Fu, Y.; Huang, Y., Shi, J. and Shang, Z. 2024.** Adding sulfur to soil improved cucumber plant's resistance to powdery mildew. *Agronomy*, 14(8): 1799.
14. **Jubair, A. F., Al-Jabry, S. M. E. and Al-Khafaf, A. A. 2022.** The use of toxic filtrate of *Trichoderma harzianum* and alcoholic extract of *Myrtus communis* leaves in protect cucumber seedling from infection by *Rhizoctonia solani*. *International Journal of Agricultural and Statistical Sciences*, 18(1): 197-202.
15. **Miller, S. A., Ferreira, J. P. and LeJeune, J. T. 2022.** Antimicrobial use and resistance in plant agriculture: a one health perspective. *Agriculture*, 12(2): 289.
16. **Ngegba, P. M., Kanneh, S. M., Bayon, M. S., Ndoko, E. J. and Musa, P. D. 2018.** Fungicidal effect of three plants extracts in control of four phytopathogenic fungi of tomato (*Lycopersicum esculentum* L.) fruit rot. *International Journal of Environment, Agriculture and Biotechnology*, 3(1): 112-117.
17. **Paap T., Brouwers N. C., Burgess T. I. and Hardy G. E. S. 2017.** Importance of climate, anthropogenic disturbance and pathogens (*Quambalaria coyrecup* and *Phytophthora* spp.) on marri (*Corymbia calophylla*) tree health in southwest Western Australia. *Annals of Forest Science*, 74(3): 1-10.



18. **Parmeter, J. R. and Whitney, H. S. 1970.** Taxonomy and nomenclature of the imperfect state. Pages 7-19 In: J. R. Parmeter Jr., (ed.) *Biology and Pathology of *Rhizoctonia solani**. University of California Press, Berkeley. 255 pp.
19. **Poudel, B. and Vaghefi, N. 2023.** Taxonomy of Macrophomina—traditional to molecular approaches. In *Macrophomina Phaseolina* (pp. 3-8). Academic Press.
20. **Tudi, M., Daniel Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., Chu C. and Phung, D. T. 2021.** Agriculture development, pesticide application and its impact on the environment. *International Journal of Environmental Research and Public Health*, 18(3): 1112.
21. **Villegas-Aguilar, M. D. C., Sánchez-Marzo, N., Fernández-Ochoa, Á., Del Río, C., Montaner, J., Micol, V., Herranz-López, M., Barraón-Catalán, E., Arráez-Román, D., Cádiz-Gurrea, M.d.l.L. and Segura-Carretero, A. 2024.** Evaluation of bioactive effects of five plant extracts with different phenolic compositions against different therapeutic targets. *Antioxidants*, 13(2): 217.
22. **Williamson-Benavides B. A. and Dhingra A. 2021.** Understanding root rot disease in agricultural crops. *Horticulturae*, 7(2): 33.

